NAI Focus Group

NASA ASTROBIOLOGY INSTITUTE

NASA Astrobiology Institute Introduction

NAI is a "virtual collaboratory" distributed across the United States and bound together through advanced telecommunications and electronic networking. The institute represents a partnership between NASA, universities, and research organizations to promote conduct, and lead integrated multidisciplinary research, to train young scientists, and to provide public access to the adventure of studying the living universe.

Focus Groups Introduction

Focus Groups are research and planning teams formed around topics relevant to specific NAI goals and objectives. Established based on proposals submitted to NAI, Focus Groups contribute to astrobiology space missions and extend long-distance collaborations through the innovative use of networking and other technologies.

Evolutionary Genomics Focus Group

Studying evolution by examining the complete genetic code, or genome, of organisms sheds light on life's origins, its adaptations to diverse environments, and its increase in complexity. Known as evolutionary genomics, this research can also help us predict where and how life may evolve on other planets. The Evolutionary Genomics Focus Group, established in March 2000, is a forum for exchanging of information and sharing ideas regarding life's beginnings and early evolution based on genomic information.

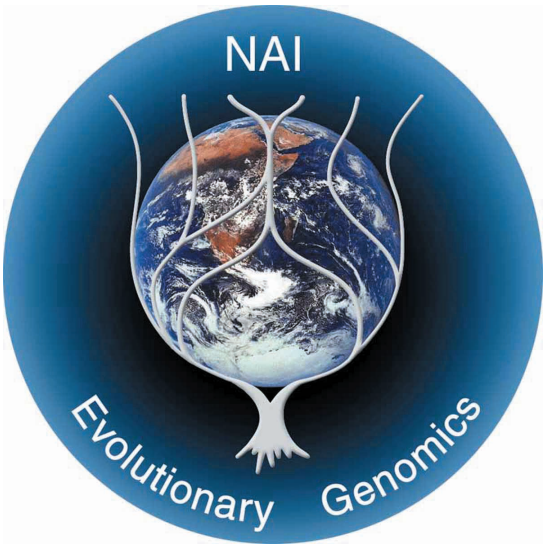
The Genomics of Evolution

The shuffling and alteration of genes in and between organisms is the foundation of evolution, resulting in species better adapted for particular environments. Since its birth as a planet, Earth has undergone vast environmental changes creating a broad array of habitats that range from temperate to a variety of harsh extremes. Over the ages, life has adapted to take up residence in most of them. Evolutionary studies of species' complexity and their associated genetic modifications will assist in understanding how life began on Earth and how it adjusted to environmental demands.

The genetic data from organisms can be used to estimate their phylogeny (the history and pattern of relationships of evolving organisms) and the chronology of their divergence from common ancestors. This information can then be mapped against environmental changes to assess the evolutionary impact of geology and climate. The Neoproterozoic period, 1000–545 million years ago, is of particular interest to astrobiology because geologic and planetary-scale climatic events challenged early metazoans (animals) with extreme and changing environments.

Other areas of pursuit relevant to astrobiology include the evolution of gene function and lateral gene transfer. Understanding the evolution of gene function can help in the identification of genes present in the earliest forms of life, and in turn, in their

Evolutionary analysis of the genomes of organisms will help to build a clearer picture of how life originated, adapted to diverse environments, and increased in complexity on this planet.

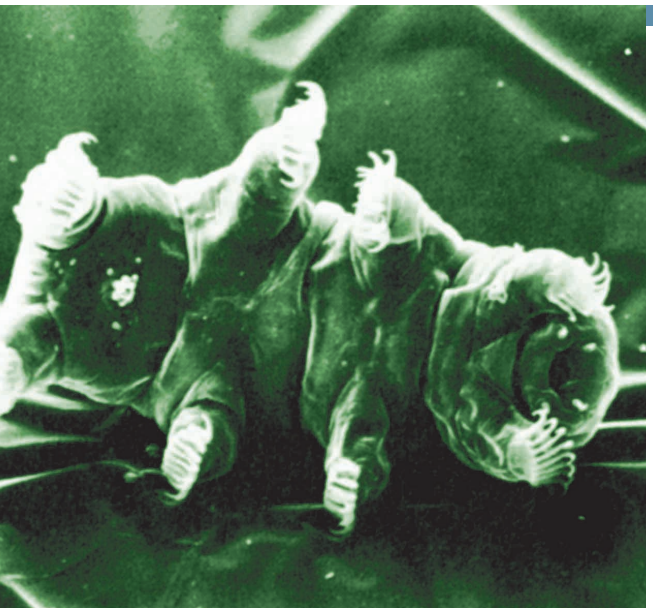


environment. Lateral gene transfer, gene movement between genomes, enables organisms to adapt to changes in the environment. Prokaryotes have experienced widespread lateral gene transfer. Genomic analyses of these organisms in diverse and extreme habitats will help to determine the effects of environmental factors on lateral gene transfer.

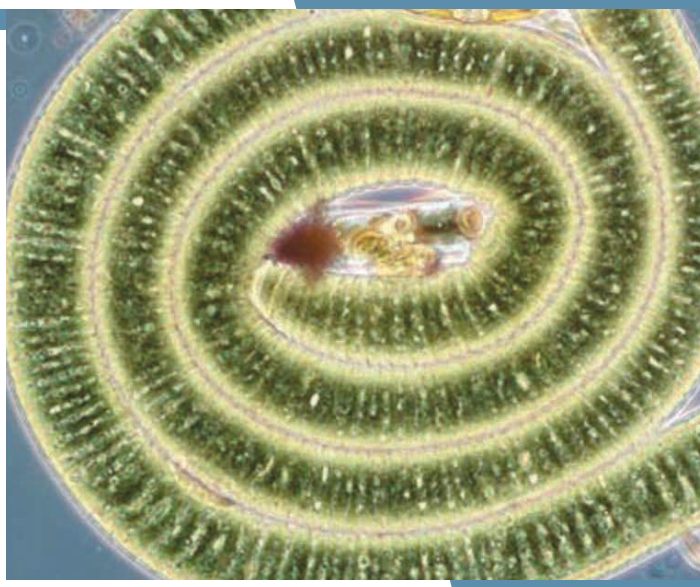
Focus Group Activities

Chaired by Dr. Blair Hedges (Department of Biology, Pennsylvania State University) and James Lake (Molecular Biology Institute, University of California, Los Angeles), the Evolutionary Genomics Focus Group includes scientists with expertise in molecular evolutionary analysis, organic chemistry, biochemistry, Earth history, and paleontology. Collaboration via electronic networking and annual workshops allows the dispersed team to perform a coordinated investigation of evolution as it relates to Earth's environmental changes through time.

The first phase of the research effort emphasizes the use of analytical and computational tools to extract information from DNA sequences of diverse organisms. These data will be used to gain insights into gene function, phylogeny, and the timing of early (Precambrian) events in the history of life. The second phase will involve sequencing the genomes of organisms significant to astrobiology that current sequencing projects have left untouched. Organisms to be targeted in this phase include key prokaryotes, basal eukaryotes, and basal metazoan phyla.



Spirulina is a spiral bacterium that moves by a cork-screw motion. Photo Credit: David Patterson, Linda Amaral-Zettler and Virginia Edgcomb.



Lyngbya may be the oldest recognizable organisms on Earth - traceable back to the earliest fossils, over 3 billion years old. Photo Credit: David Patterson, Linda Amaral-Zettler and Virginia Edgcomb.

Focus Group activities will provide information important for upcoming NASA missions. The team's findings on the molecular evolutionary history of life on Earth will be used as a comparison for any evidence of extraterrestrial life found by the Mars and Europa Orbiter missions. Specific activities have included collaborative research, several videoconferences, a workshop, construction of a Web site, presentations, and other meetings with the topics of Neoproterozic evolution and the impact of global glaciations taking center stage. Group interaction and collaborative research are expected to continue at an active pace.

NASA Priorities

The Evolutionary Genomics Focus Group activities address several of the Astrobiology Roadmap goals:

- Origin of Life's Cellular Components
- Models for Life
- Genomic Clues to Evolution
- Linking Planetary & Biological Evolution
- Extremes of Life
- Past and Present Life on Mars
- Effects of Climate & Geology on Habitability
- Extrasolar Biomarkers
- Ecosystem Response to Rapid Environmental Change

Evolutionary Genomics can help us build a clearer picture of how life originated, adapted to diverse environments, and increased in complexity on Earth. Through its research, the Evolutionary Genomics Focus Group will, in turn, provide astrobiology with a clearer picture of what life on other planets might be like.